National Aeronautics and
Space Administration

# Rocketing to the Future - Upgrading the Space Shuttle

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Since its introduction in 1981, the Space Shuttle has completed more than 100 flights. It has ferried more than 3 million pounds of cargo to space and carried more than 625 passengers. It has launched space observatories, spacecraft to the Sun and planets, and a variety of communication and scientific satellites. It has supported two space stations, carried service teams to the Hubble Space Telescope three times, and rescued stranded satellites. Scientist astronauts on board have conducted hundreds of experiments on the effects of microgravity on materials, plants, and animals. The Space Shuttle has become a multipurpose vehicle that is preparing humans for greater adventures in space.

The outside of the Space Shuttle looks pretty much as it did when it first traveled into space two decades ago. The inside, however, is another matter. The Space Shuttle has undergone continuous improvement in all of its systems. One of the latest improvements is the "glass cockpit." The original cockpit of the Space Shuttle orbiter looks primitive by today's home computer standards. It featured many mechanical dials, gauges, and green screen cathode ray tube displays. The glass cockpit replaces four cathode ray tube displays and 32 gauges and electromechanical displays. The nine new color computer display screens provide all the information Space Shuttle flight crews need during launch, orbital maneuvers, and reentry and landing. The displays are easier to read and can be changed to provide additional control functions and system information as needed. Additionally, the new glass cockpit is lighter and uses less electricity than the original cockpit. Most importantly, the new cockpit provides the flexibility to further improve software and displays, creating a simpler "smart cockpit", which in the next few years will reduce the pilot's workload during critical periods.

Upgrading the cockpit isn't the only thing taking place on the inside of the Space Shuttle. Since it was first built, the Space Shuttle has been continually improved. The external fuel tank has been lightened by more than eight tons, allowing the Space Shuttle to carry that much more weight into space. Many items inside the cabin — such as seats and lockers — also have been lightened, built out of composite materials rather than metal. A series of improvements to the main engines have made them an estimated three times safer today than when the Space Shuttle first flew.

Future improvements now being developed will make the Space Shuttle even safer. Those improvements include replacing the auxiliary power units that power the flight control surfaces on the orbiter's wings and tail, and replacing the steering mechanism for the engines. Today, the units use highly volatile and toxic rocket fuel. New units will use safer electric motors and batteries. Another set of improvements to the main engines will include high-tech optical and vibration sensors that, in a fraction of a second, can detect problems before they do harm. The engine design will be simplified, eliminating the need for 150 meters of welds in the engine nozzles and lowering the engine pressure to reduce wear without reducing thrust. Improvements also are being developed for the solid rocket booster steering system, improving the reliability of valves, filters, and seals.

Because of past improvements, today's Space Shuttle is safer, more capable, and more efficient than ever before. The goal of the new improvements is to increase safety even further, cutting the risks of launching the Space Shuttle in half from what they are today, and ensuring that the Space Shuttle is ready to continue transporting people and equipment into space for years to come.

**For the Classroom**

1. Take a virtual reality tour of the Space Shuttle glass cockpit at the following internet address:
   *http://spaceflight.nasa.gov/gallerycockpit_tour/*

2. Follow the preparation of Space Shuttle missions by accessing the following internet addresses:
   *http://spaceflight.nasa.gov/shuttle/*
   *http://images.ksc.nasa.gov/*

3. Construct a scale model of the Space Shuttle orbiter and take the Space Shuttle Glider Challenges. You can download the Space Shuttle Glider at the following internet address:
   *http://spacelink.nasa.gov/products/Space.Shuttle.Glider*

Please take a moment to evaluate this product at
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